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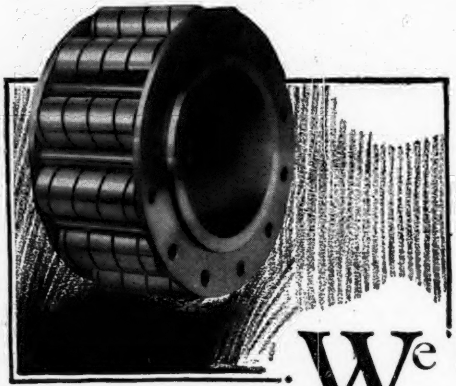

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Research in Agricultural Engineering*

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MANY of the features now embraced in the subject of agricultural engineering have found employment in the art since early times. In a large measure the application of engineering to agriculture has increased with the advance of the industry, and in many instances it has been the primary cause of epoch-making progress. But as a recognized branch of agricultural teaching its organization is relatively recent, and as a subject of investigation it has not yet become widely established. In the latter respect it may be said to have lagged behind several related branches which are hardly of less fundamental importance.

The development of implements, machinery, and mechanical power to make man's efforts more effective and more productive is one of the most prominent features in progress; a better structure and more effective building and storage facilities are everywhere a mark of such progress. Add to these features the application of water to the soil where and when needed, its removal where present in excess, the subduing of land otherwise unfit for cultivation, and the provision of the facilities of the modern country home, and it will be evident what a large part agricultural engineering plays in the process of gaining and exercising dominion over the earth.

In recent years this branch has been steadily making its way, first as a teaching subject, then as a service branch, and gradually taking its place in the field of investigation. This latter development is not only logical, but is one of the features which at the present time are deserving of special encouragement. There can be no question that the purely mechanical and rule-of-thumb methods which have been followed need to be subjected to the same rigid scrutiny that other branches of farming have received. That the opportunity is open hardly needs argument. It is already recognized that tools and implements built and operated without mechanical or mathematical precision often embody undesirable features such as lost motion, wasted energy, or lack of durability or reliability, and in some cases are not fully adapted to the needs sought. Indeed these ends are themselves not always clearly understood. Building and storage structures planned and erected without consideration for warmth, light, ventilation, to say nothing of strength and durability, have proved uneconomical and inadequate. They do not take account of the advances which science has taught in the storage of crops, the housing of stock, and the care of dairy animals. Thus in order to keep abreast of the times it has become necessary to seek out and apply engineering principles in the development of the mechanical, electrical, hydraulic, and other engineering processes involved in modern farming, and to adapt these to the modern teaching of agricultural science.

*An editorial by R. W. Trullinger, reprinted from "Experiment Station Record," published by the United States Department of Agriculture, Vol.45, No.2, August, 1921.

In the beginning of agricultural engineering old and well-established engineering principles were naturally applied as far as possible, but it soon developed that the problems of agriculture requiring engineering treatment are more or less specialized. They present conditions and requirements which are of a special nature, which have to be taken into account. This brings out the advantage of the agricultural outlook and contact, and at the same time it presents the opportunity for investigation immediately adapted to the situation. Certain of the engineering principles and formulas originally used are found to need intelligent modification or development, and again new facts and special information must be established to meet the requirements in many special cases.

TRUE RESEARCH RARE IN AGRICULTURAL ENGINEERING

While considerable progress has been made in providing a broad background and to some extent in the formulation of purely agricultural-engineering principles, the development of inquiry along advanced lines has been relatively limited, and there is a feeling among some that this branch has not kept pace with the rapid advance in other branches of agricultural science. It is undoubtedly true that, from the nature of the situation, considerable of the activity in agricultural engineering has consisted of teaching, extension, and expert service, rather than a searching after and disclosing of new information. The fact that there is a demand for the former is proof that at least some of the latter should be developed, to lead the way and stimulate gradual advancement in the subject. This will require opportunity—not only facilities, but time and freedom and a sustaining support which will encourage and give protection. Manifestly in a new subject like this various types of activity will be needed, just as they have been in horticulture and agronomy and other branches. It will be useful to make comparative trials, to apply known facts and principles in designing appliances and structures, to employ the skill and judgment of the engineer in a variety of ways to matters which have a bearing on agriculture; but without losing sight of the agricultural connection or purpose, a certain amount of investigation or carefully considered research will be a means of growth and enable rank to be taken with other departments of agricultural science.

A survey of the project lists of the experiment stations shows a relatively small number of projects in the field of engineering. The majority of these are rather elementary, relating to design of structures, comparisons of implements or methods, surveys for engineering enterprises, and the like. There is no intention, of course, to disparage any of these, but the record shows very few projects of actual research grade. As a matter of fact, no project in agricultural engin-

eering has ever been submitted for the Adams fund, a fact which, although it does not necessarily indicate the absence of such projects, suggests that the field has attracted but little attention.

Research is often used in a rather loose and broad sense. It may very properly be reserved for types of effort which, besides being systematic aim at something more than comparisons, involving originality in procedure or in the end product, and as a rule resulting in facts rather than in material things. It is well to maintain these distinctions in agricultural engineering. Standards, of course, advance with the progress of the subject, and what is recognized as research at one stage will lack the essential qualities at a later stage because of the progress which others have made. It will be well to recognize research in agricultural engineering as the pursuit of knowledge having a basis in science, not merely the means of testing or perfecting a particular mechanical device. It aims to consider all the factors and principles involved and the purpose sought to be accomplished, as well as the mechanical ingenuity involved in the product. It must naturally take into account the purpose which is to be accomplished by the appliance or operation, and this often brings engineering research into intimate relation with other branches of agricultural science. Progress is the watchword of research, and research is the basis of advancement of any branch of pure or applied science. Unless agricultural engineering can be developed as a research subject, it will lag behind, will borrow its fundamentals from physics, chemistry, agronomy, and other branches, and will be in danger of remaining largely a service department occupied with the application and adaptation of what is known and its teaching. To secure a certain degree of independence and to grow of its own effort, the subject ought to have the elements of growth within itself, and these need to be visualized and set in motion by leaders in that field.

The formation of the American Society of Agricultural Engineers was a recognition of the position this subject has attained and the need of organized means for advancement. It has given a decided impetus to investigation in that line and has tended toward the development of methods and the setting up of standards.

For several years the Society has had a research committee which has been engaged in determination of the status of scientific information, the analysis of needs for research, and the formulation of methods of procedure in the plan and execution of specific projects. This study has developed a considerable record of inquiry extending back for a quarter of a century, from which has been derived a considerable part of the basic facts and principles upon which present knowledge of agricultural engineering rests. Some of the hydraulic formulas used in irrigation and drainage are illustrations of the results of this work, and it is also reflected in the development of certain farm machinery and other appliances.

DETERMINATION OF RESEARCHES NEEDED

The study has also disclosed a large amount of simple testing and experimentation resulting in data for the most part of rather limited application and less permanent value. This is particularly true in the case of certain matters relating to rural sanitation, and in the farm-machinery field much of the experimentation has been of relatively limited fundamental character in proportion to the importance of the subject and the opportunity offered. It is found that too often such work has apparently lacked definiteness of plan and fundamental aim, or has been conducted to meet a superficial need rather than to derive broad general facts. The character and the paucity of the work in some directions, it is believed, has tended to retard the progress of agricultural engineering as a teaching subject and along applied lines.

One important feature in the development of investigation in such a subject is a survey of the field in order to determine the most desirable lines along which investigation should be conducted at the present time and to provide bases from which to operate. Such a survey naturally deals largely with the available scientific information and the technical and economic conditions involved. It thus opens up avenues for profitable inquiry and directs attention to the types of problems and the character of work especially needed.

This the research committee of the Society, working in connection with the college section of that organization, has for some time been engaged in, and has brought forward some fifty specific lines along which investigation and experiment are deemed desirable. The subjects embraced include all of the main branches of agricultural engineering and have been selected as the most pressing and the most representative of agricultural interests throughout the United States. The work of the committee has not only established the need of determining underlying facts and principles in a number of lines and establishing the influence of prevailing conditions, many of which are now more or less speculative in character, but it has pointed to the importance of planning and executing projects with a definite aim in each instance.

EVOLUTION OF THEORY VS. EMPIRICAL DEVELOPMENT

Inquiry in this subject, as in all others, must be planned and conducted with vision and understanding of the real nature of the problem to be solved. Unless this is done the end sought may not be a profitable one or the work may be of purely tentative value. For example, it would be well nigh useless to derive a formula for a plow moldboard until it was scientifically clear what a moldboard was designed to accomplish in a given soil or for a certain purpose. The purpose sought to be accomplished is the proper starting point in designing, perfecting, or testing an implement; but it will be recognized that it is a point frequently neglected, with the result that the planning is faulty and the results give divergence of opinion. There is a profitable field for study of the theoretical basis of plowing, and such a study would involve a group of several agricultural specialties.

The complex nature of the problems in agricultural engineering emphasizes the need of the same broad preparation and inculcation of the research spirit which prevail in other lines of advanced inquiry. There is need in that subject of understanding which rests on principles and the relation of conditions, as well as the requirement of facts and skill and ingenuity. In the training of agricultural engineers stress is naturally laid on ability to do things, to apply rules, to be resourceful in meeting specific conditions effectively. Attention is less rarely given to training in the acquisition of knowledge which is new, in questioning the reason for a process, or raising a doubt as to an empirical fact. The difference between experience and sound practical judgment on the one hand, and investigation directed toward the establishment of new scientific facts or a better understanding of principles and relationships on the other, is as great in agricultural engineering as it is in agronomy or animal feeding; and the development of the proper attitude is as essential to success in engineering research as it is in any other branch of scientific or technical inquiry.

The requirements for successful investigation are somewhat different from those of engineering practice. The planning and execution of scientific inquiry calls for the exercise of vision, the knowledge of the means of solving scientific problems, and the spirit which demands to know the meaning of the fact as well as the bare fact itself. Hence the individual engaged in the planning and execution of research in agricultural engineering needs not only to be trained in engineering matters but to be trained in research, its methods and spirit as well; he needs to have both the time and the patience for his investigations to make them thorough and searching.

The strengthening of investigation in this field will call for the formulation in their research aspects of some of the things which need to be done. If there are problems to be solved which depend on more fundamental inquiry, on the development of methods which will give more trustworthy or more intimate knowledge of the facts and conditions involved, it should be possible to formulate these so that they will stand out with force, and thus to open up the field. The setting forth of the real nature of the questions which come to the engineer will serve to illustrate best of all the essential features involved in scientific inquiry and will prepare the way for leadership in developing the field. Some of these problems will be so broad in their fundamental character that they will require the help of specialists in other lines, and will thus lead to cooperation; in this the engineer need not play an incidental part, but ought to be able to contribute something which none of the other specialists can.

The American Society of Agricultural Engineers has a highly useful function in guiding and stimulating inquiry and in paving the way for cooperation. It represents a viewpoint which should serve to bring out important questions likely to be overlooked by specialists in other branches. It can emphasize the importance of engineering being taken into account in connection with various other problems of a comprehensive nature. Already the Society is attempting to establish better cooperative relations between federal and state agencies, between institutions in different states, and between the agencies within individual states which have common interests in agricultural-engineering questions. On the basis of topics which its survey has shown to be important it will develop plans of procedure which will be subjected to the critical scrutiny of its committees and of the Society as a whole. Such an organized effort as this is of no small interest to the agricultural experiment stations, many of whom are represented in the Society, and it will likewise be of much interest to station directors in setting forth the field and the desirability of development in that line of inquiry.

The provision thus far made for investigation in agricultural engineering at most of the experiment stations is relatively small. In the majority of cases the engineers are largely engaged in teaching and extension work, or in designing structures or plans to meet the needs of applicants. The actual experimental work occupies a rather subordinate position in spite of the fact that both the teaching and extension work depend largely upon the results of research for their progress and development. The result is that the engineer does not have the opportunity and is not always given the encouragement for digging deep and supplying an increasingly broad and strong foundation for his specialty. This may sometimes be due to his own inclinations or preferences and sometimes to the conditions under which he works, but until both the need and the ability are shown for more fundamental investigation in engineering support may be relatively slow to materialize.

There is undoubtedly opportunity and need for a type of study which will go beyond comparisons, will attempt to trace the true relation between conditions and results, will make engineering as applied to agriculture less empirical and rest it in a larger measure upon facts and principles which it is itself helping to establish. It is recognized, of course, that for a time at least much of the work of the agricultural engineer must of necessity be of rather elementary nature and immediately practical aim, and will rest in considerable measure upon his general information, mechanical ability, and practical qualities. But if this specialty is to grow it must be through research which is searching and severe and the department must not be exclusively a teaching and service department or restricted wholly to practical affairs.

This will require that agricultural engineers be given the same consideration as other branches of agriculture in the provision of funds and facilities. Both men and opportunity will need to be provided. In general, perhaps, the specially trained personnel will not be forthcoming until the opportunity presents an attractive field. In some instances it may be necessary to train men in part, or to adapt specialists to this field in order to work out certain types of problems. The opportunity for leadership both in planning and in execution would seem to be a large one.

Handling Quicksand in a Well

EDITOR AGRICULTURAL ENGINEERING:

I WOULD like to get in touch with members of the Society for information as to the best way of handling quicksand in a well. There are different kinds of quicksand but my problem is the handling of ordinary quicksand in both a drilled well and a dug well. In the drilled well I expect the best way is to drive the casing on through the quicksand, but in some cases this is not the practical thing to do. Theoretically, I believe the proper thing is to put in some gravel on the bottom and then on top of that finer gravel, gradually working up until fine sand is on the top, the idea being to keep the quicksand down by giving a multitude of openings for the water to work up, the weight of the sand and gravel to serve as pressure on the bed of quicksand to keep it from flowing in.

L. F. BEERS

EDITOR'S NOTE: Members of the Society who have had experience in handling quicksand in wells are requested to send the Secretary what information they have on this subject. In addition to sending such information on to Mr. Beers the Secretary would like to have it also for the reference files of the Society. Prompt attention to furnishing the desired information will be appreciated.

Preserving Fence Posts

IN THE annual report of the Iowa agricultural experiment station for the year ending June 30, 1920, the results of experiments in the preservative treatment of fence posts are briefly given. In 1905 twenty experimental fence lines were set in various counties of the state in cooperation with farm owners. Posts cut from the common Iowa woods were used. The species set included willow, cottonwood, soft maple, basswood, box elder, ash, butternut, and others, which were treated with creosote by the "open tank" method. After fifteen years of service in fence lines, a large percentage of these cresoted posts are sound and give evidence of being able to withstand decay for an additional number of years. The same timbers when used without creosote treatment last only from three to five years. The results indicate the desirability of using the inferior soft woods of the state for fencing purposes. The experiments also demonstrate the great saving which may be effected in creosoting white cedar and other posts shipped in from other states. Approximately 25,000,000 fence posts are used annually in Iowa. If creosoted posts were used entirely, the annual consumption of posts in the state would be reduced to 10,000,000 or 12,000,000.

Effect of Spacing Drilled Rows on Yields

THE Iowa agricultural experiment station reports that five years results in comparing different distances of spacing drilled rows in seeding oats show that, as an average, oats drilled in rows six and eight inches apart have given a yield of approximately three bushels more than when the rows were spaced four inches apart.

Picric Acid as an Agricultural Explosive

By **John Swenehart**

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PICRIC acid (tri nitro phenol) is one of the explosives which was left when the armistice was signed and which has since been declared surplus by the War Department and turned over to the United States Department of Agriculture to be distributed through the various state agencies for land clearing purposes. On account of its comparative insensitiveness, disruptive properties, melting point, and other properties, it was particularly desirable for war purposes. In order to put this surplus material to productive peace time use the United States Bureau of Mines, the land clearing section of the college of agriculture at the University of Wisconsin, and U. S. Bureau of Public Roads conducted experiments and investigations. Laboratory and chemical tests were made by the Bureau of Mines, and the field and practical tests were made by the University of Wisconsin.

Picric acid is a fine, yellow, crystalline powder. Dry picric acid is very fine and free running. The picric has a very disagreeable, bitter taste, and when moist stains the skin a yellow color. It is slightly soluble in cold water and a little more so in hot water.

Much of the explosive turned over by the War Department contains ten per cent or more of water which has been added to comply with War Department specifications. This wet material is entirely insensitive to shock even from detonating caps.

Removal of moisture is the first operation in the preparation of picric for use as an agricultural explosive. When all of the moisture is removed, the material is too dusty for economical cartridging operations on a commercial scale. It is necessary to eliminate the hazard from dustiness and at the same time not desensitize the material. Investigations at the University of Wisconsin showed that two per cent of water left in the material relieved the dust hazard and made it possible to cartridge the picric acid on a commercial scale. Two per cent moisture reduces the sensitiveness of the picric acid to some extent but detonation is practically complete if No. 8 blasting cap is used. A one per cent moisture content was not sufficient to allay the dust and three per cent moisture or more made the explosive difficult or impossible to detonate with ordinary means.

Picric acid dries out in air to one or two-tenths of one per cent moisture in a very short time. No matter how much moisture was left in the material and when cartridging was very carefully done, the moisture content would decrease. A mixture containing three per cent water was found to contain two to two-and-one-half per cent moisture after less than twenty-four hours. Within a week, this three per cent moisture would often be reduced to one or one-and-one-half per cent. When the picric acid was packed in unparaffined paper shells, the moisture content was found to go down rapidly even when the filled cartridges were immediately paraffined after filling. It was possible, in cartridging operations where a good grade of paper was used for the shells to cartridge the picric acid in undipped shells with the picric acid containing much more moisture than would be usable in the finished product. Picric acid containing three to four per cent moisture when cartridged in undipped shells, was dried to contain about two per cent. The picric acid is not hydroscopic and does not normally absorb water.

Cartridges of picric acid used in the field tests were made of seventy-pound manila wrapping paper. The shells were dipped before filling in paraffin and again after filling. The finished cartridge was approximately 1¼ inches in diameter and eight inches long, weighing approximately 6 to 6¼ ounces. Standard commercial detonating caps, both electric and common, were used in the trials. The picric acid was checked against Grade III TNT to determine approximate strength.

Picric acid detonates with a distinct ball of fire visible by daylight when the explosion is in the open air. The smoke is dark gray in color when detonation is complete. When explosion is incomplete, a yellowish or greenish colored smoke occurs which apparently contains unexploded picric acid.

A mixture of one per cent ordinary light automobile lubricating oil with the air dry picric acid was found to give results approximately the same as were obtained with two per cent moisture. The oil effectively allays the dust and the picric acid containing one per cent oil could be detonated completely with No. 8 caps. However, as water can be safely used, it is cheaper and more economical to leave the moisture in the material rather than entirely dry it and add the oil.

Picric acid as compared with dynamite is more insensitive both to detonation and outside shock. Picric acid passes the standard pendulum friction tests of the Bureau of Mines using the steel shoe. This is a more severe test than any ordinary field condition common to stump blasting. Two per cent moisture added to picric acid renders the material entirely unaffected by 30-caliber Remington high power rifle bullets at from 50 to 60 feet. Dry picric acid can be exploded at 50 feet with this rifle.

Picric acid burns about as readily as TNT. It burns quietly without explosion in small quantities. Regular cartridges placed on the ground in the open burned in 8 to 12 minutes each. It is ignited with difficulty. Burning ordinary fuse laced through the cartridges did not ignite picric acid. The common practice of lacing fuse in priming may be safely done. Even damaged fuse failed to ignite this explosive when laced through cartridges.

Moisture encountered in ordinary land clearing operations was found to have no more effect on picric acid than on ordinary dynamite used. The determining factor in moisture seems to be the quality of the cartridging work

TABLE I—DETONATION OF PICRIC ACID

Cap	Condition of Picric Acid	Size Cartridge	Place	Detonation	
8	Dry (—0.5%)	5 oz.	Air	Complete	Grey smoke
6	Dry (—0.5%)	5 oz.	Air	Complete	Grey smoke
8	1% water	6 oz.	Air	Complete	Grey smoke
6	1% water	6 oz.	Air	Complete	Grey smoke
8	2% water	6 oz.	Air	Complete	Grey smoke
6	2% water	6 oz.	Air	Complete	Grey smoke
6	2% water	6 oz.	Air	Incomplete	Green smoke
8	3% water	6 oz.	Air	Complete	Grey smoke
8	3% water	6 oz.	Air	Incomplete	Green smoke
6	3% water	6 oz.	Air	Incomplete	Green smoke
6	5% water	7½ oz.	Air	No detonation	
8	5% water	7½ oz.	Air	Incomplete	Green smoke
8	5% water	7½ oz.	Air	Incomplete	Green smoke
8	1% lubricating oil	6 oz.	Air	Complete	Grey smoke
6	1% lubricating oil	6 oz.	Air	Complete	Grey smoke

TABLE II—Moisture Resistance

PLACE	Length of Time	Condition of Material	No. of Cap	Result
Wet soil. Water in bore hole......	15 min. to 16 hrs.	2% water	8	Complete
Sloppy soil. Edge of crater.....	24 hrs.	1% water	8	Complete
Sloppy soil. Edge of crater.....	24 hrs.	2% water	8	Incomplete
Sloppy soil. Edge of crater.....	24 hrs.	3% water	8	No detonation
Water in bore hole..	1 hr.	2% water	8	Complete

All cartridges were double paraffined and slit so as to pack firmly in bottom of hole.

done and the thoroughness of the paraffining operation. Picric acid is less affected by water than ingredients of dynamite. Table II shows results under different moisture conditions in the soil. Cartridges unbroken and left in sloppy, wet soil for twenty-four hours have apparently perfect detonation. Cartridges lit from end to end three or four times and thoroughly tamped into bore holes in moist soil, were unaffected on being left over night.

Dry picric acid apparently repelled moisture to some extent. After water has actually been introduced and mixed with the picric acid, it was found that the effect of water in the bore hole was much more pronounced. The nature of the picric acid in giving off water under ordinary conditions means that it is seldom that operations will be carried on with material containing more than one per cent of moisture.

According to the report from the Bureau of Mines, various temperatures which would be encountered in agricultural work have no effect on dry picric acid. As a further test, picric acid containing two per cent moisture was placed in a freezing mixture of ice and salt until a temperature of six degrees above zero (Fahrenheit) was reached. These cartridges were immediately fired in the open and also in the ground with no apparent effect from the low temperature.

According to the Bureau of Mines investigations and the long experience of Dr. Munroe, picric acid has no bad physiological effects, either in connection with the handling of the raw material by absorption through the hands or from the dust. In these tests the picric acid was handled both dry and moist by seven different men, by some of them daily from three to six weeks, and no physiological effect was apparent. Yellow stains on hands and body through contact with picric acid disappear in a few days without ill effect. The fumes from explosion, while containing considerable carbon monoxide and other gases, disappear quickly and need not be a factor of importance in the handling of picric acid. The question was raised as to the effect of moist picric acid on metals, particularly in the soil, as picric acid, iron, and calcium compounds are known to form dangerous compounds with these substances. In order to get extremely favorable conditions for formation of these picrates, twenty-five per cent of lime freshly slacked was added to the soil and moisture added to make a wet mud. Cartridges were left in this mixture for twenty-four hours. A sympathetic sensitive test at the end of this time revealed no increase in sensitiveness as a result of the contact between the lime soils and picric acid containing two per cent moisture. The same trial was made using twenty-five per cent of iron dust from an emery wheel with no increase in sensitiveness. It appears from these results that any picrates which may have been formed were desensitized from the water which was taken up in contact with the wet soil which permitted their formation. On account of the extreme conditions under which these tests were formed, it is thought that under the ordinary soil conditions with limited quantity of the iron and calcium contained, that no dangerous picrate would be formed without the moisture entirely drowning it. Hundreds of loads in moist soils containing both iron and lime substantiated the conclusion that dangerous compounds were not formed in agricultural practice.

Sound white pine stumps were deemed most desirable for tests of explosives on account of their being more readily measured and compared. Stumps were selected on different soils and under different moisture conditions. The clay soil was a superior red clay containing high iron content but low in lime. The sandy soil is similar to the usual light soil, containing but little clay but sufficiently productive for agricultural use. Table III shows results of a few of these trials. The trials show that the picric acid is about thirty to forty per cent stronger than ordinary dynamite used for stump work. As compared with TNT it is approximately equal in strength, perhaps the picric acid has a little bit the advantage in strength considering the great many trials. Action of picric acid is not as slow as low grade dynamite. It is more like the 40 or 50 per cent straight nitro-glycerine dynamites. This means that it is as desirable for stump removal as low grade dynamites. In stump removal a cheap dynamite of slow action is most desirable. The two per cent moisture which was added to the picric acid for ease in cartridging seems to reduce the speed of the explosive and makes the result even better than is the case with the dry material which is extremely shattering.

This high shattering effect makes the picric acid a desirable explosive for mud-capping or bull-dosing rock. The explosive is placed against the rock and a large layer of heavy mud is placed on top to give the explosive a chance to act. Obviously a quick-acting explosive is more desirable for this work.

The insensitiveness of picric acid makes it undesirable as an explosive for ditch work because it requires a cap or detonator in each charge. In order to get effective work, an electric blasting machine and electric caps are necessary. This cap being more expensive increases the cost very materially. Propagated blasting cannot be practiced.

Due to the insensitiveness of the picric acid it is also advisable in any work, either ditching, rock work, or stumping, to have the picric acid charge bunched as much as possible. Full effectiveness is not secured from a charge placed in a long narrow bore hole with one detonator.

Particular mention is made of the last column in Table III which is ounces per square inch of cross section area of

TABLE III—Stump Removal With Picric Acid

Stump No.	Size[3]	LOAD Oz.	LOAD Condition	Cap or Primer	SOIL Kind	SOIL Condition	Oz. Per sq. in. Cross Section of Stump
24	31	20 P[1]	1% water	1—8	Clay	Moist	.022
25	33	20 P	1% water	1—8	Clay	Moist	.023
30	33	24 P	1% water	1—8	Clay	Moist	.028
31	48	41 P	1% water	1—8	Clay	Moist	.023
55	35	31 P	1% water	1—8	Clay	Moist	.0[illegible]2
44	31	48 P	1% water	1—8	Sand	Moist	.0635
45	37	61 P	1% water	1—8	Sand	Moist	.0567
32	41	33 P	2% water	1—8	Clay	Moist	.025
37	37	36 P	2% water	1—8	Clay	Moist	.0335
39	32	28 P	2% water	1—8	Clay	Moist	.0298
40	28	18 P	2% water	1—8	Clay	Moist	.0292
42	58	72 P	2% water	1—8	Clay	Moist	.0[illegible]72
51	22	30 P	2% water	1—8	Sand	Moist	.0790
52	44	96 P	2% water	3—8	Sand	Moist	.0631
64	30	48 P	2% water	2—8	Sand	Moist	.0679
69	25	20 T[2]		1—8	Clay	Moist	.0314
70	24	14 T		1—8	Clay	Moist	.0310
71	41	33 T		2—8	Clay	Wet	.0250
72	43	39 T		2—6	Clay	Wet	.0268
73	42	36 T		2—6	Clay	Moist	.0261

[1]P, picric acid.
[2]T, TNT.
[3]Diameter of stump for cross section is taken at 1 foot above ground.
Results where load was too light or too heavy are not included in this table. Complete removal of the stump was effected in each case.

the stump. This should by no means be taken as a factor in determining quantity and material to use for removing any given stump. The various conditions under which land clearing is done modify this factor very materially as may be noticeable from examination of results in clay soil as compared with the results in sandy soil, all other conditions being the same. In order to make these results approximately comparable, all loads which were apparently too heavy or too light are eliminated from consideration. The stumps recorded are those where the explosive just removed the stump but did not throw the pieces far from the crater. Special factors such as rotten stumps and different soil formations in the same stump, cause the elimination of those particular specimens from the data.

Results of these experiments was the recommendation of picric acid for use in open air agricultural work, providing the material could be placed in the hands of the consumer at a cost lower than commercial explosives. The material can be used with entire safety and will give good results. Cost of manufacture is too high for use as a land clearing explosive after the war surplus is gone.

A New System of Barn Ventilation*

By L. J. Smith

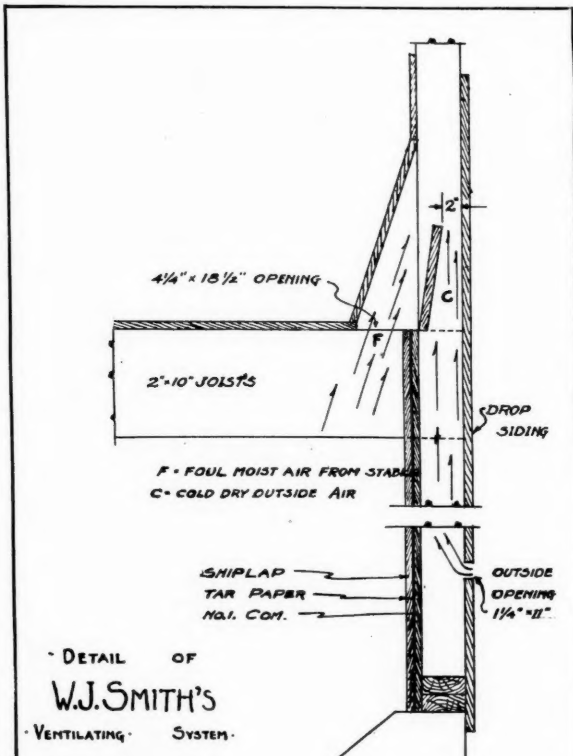
Member A.S.A.E. Professor in charge of Agricultural Engineering, State College of Washington

IN THE milder parts of the country we should more and more emphasize the necessity of ventilation from the standpoint of avoiding a stagnation of the air volumes in parts of the barn, and more important still to control the stable temperatures. The matter of proper control of stable temperature is of vital importance and cannot be emphasized too much. Tests of the carbon dioxide content in the air are merely an index as to ventilation and not an end in itself. It is extremely important that the temperature of the barn be kept under proper control which a ventilating system will do and that also a well-established ventilation system will prevent stagnation of air in parts of the barn which to my mind is of great importance, for one can have a good current of air ventilation through a barn and make very satisfactory tests and yet, on the other hand, may find that certain portions of the barn will be very stagnant as far as the air movement is concerned.

Herewith is a preliminary report of a test I made of W. J. Smith's barn north of Portage La Prairie, Manitoba, in the winter of 1920. I had hoped previous to coming to Washington to have gone into the matter of this type of ventilation more fully, especially due to the fact that the barn itself was not properly equipped to carry out the test in a highly satisfactory manner. The material I am presenting will be of special interest because it involves a new principle in ventilation which may or may not be of considerable importance, namely, that of introducing a comparatively small portion of cold dry outside air into the outtake flue which outside air in warming and expanding will take up a large proportion of the moisture in the warm, moist, outgoing air, thereby making it possible to get rid of that air without condensation in a fairly poor outtake flue. The accompanying sketch, Fig. 1, will give a good idea of the system employed.

The outtake flue consisted merely in boarding up the pair of two-by-five rafters and two-by-four studding, carrying the flue on to the peak of the barn where it was connected to a rather crude galvanized iron cowl. This cowl was clogged up quite noticeably with frost at the time of the test, and I think had some influence on the tendency for the flue to back draft, which was done to a certain extent but not seriously.

Mr. Smith came into my office one day in the summer previous to the test to explain the system to me and tell what it would do. He has a great deal of faith in this system, of course, and it has attracted quite a considerable amount of attention among the veterinarians in that part of the province. I was, of course, very skeptical in regard to the possibility of carrying moist, warm air from the stable up between a pair of studding and out through the roof of the barn without the crude flue becoming filled with frost. I was quite surprised, however, during the test to find that while there was some dripping found from the outtake flue, which was built very crudely indeed, yet it did not fill with frost during the severe temperatures indicated in the report, and the weather conditions before and after the time of the test were equally severe being below zero all of the time. The results in the report of the test are rather meager, but they are indicative of the possibility of something worth while in this type of outgoing flue, and Subcommittee on Ventilation of this Society might do well to look rather carefully into the matter of just what effect cold dry air has when mixed with warm, moist air in an outgoing flue. This is a matter to be handled from the physicists standpoint and I think our com-



*A portion of the report of the Subcommittee of Farm Building Ventilation to be presented at the fifteenth annual meeting of the American Society of Agricultural Engineers held at Chicago, December 27, 28 and 29, 1921.

mittee may find it rather interesting.

Barn Data

Date of test: January 20 and 21, 1920.

Type Barn: Saddle Roof with loft.

Capacity: 20 horses and 6 cows.

Volume: 14,040 cubic feet, 540 cubic feet per animal.

Height of stable: 9 feet to under side of loft floor.

Construction: 2x4 studs, 2x5 rafters, drop siding, outside studs, common boards, tar paper and shiplap on inside studs. Studs and rafters, 24 inches on centers. Loft floor, shiplap only, no ceiling under loft joist. Note: Loft floor thinly covered with average of one foot of sheaves and straw. The average temperature for 24 hours was 44 degrees Fahrenheit. Greatest variation, 5 degrees dropping to 40 degrees while cleaning out barn.

Results of Tests

Afternoon of Tuesday, January 20,1920, (1:50 to 4:45)

Wind southwest, steady until about 5 P.M., then changed to west with velocity 10 to 11 miles per hour.

Outside temperature—1:15 P.M. zero; 4 P.M. 2 degrees above zero; 5:15 P.M. 5 degrees below zero.

Inside temperature—average about 44 degrees Fahrenheit.

Outtake flues open, 2; intake flues open, none.

Change of air per hour, 1.41 (average of 8 flue tests).

Cubic feet per hour per animal (25 in stable)—792.

Average volume through each outtake flue per minute—165 cubic feet.

Greatest variation from average—9.7 cubic feet.

Note: 25 animals in stable until 4:30 when one additional horse came in. Evening of Tuesday, January 20, 1920, (8:30 to 9:55)

Wind—At 8:15 slightly south of west and same velocity; at 10 P.M. slightly north of west, velocity 7 to 8 miles an hour.

Outside temperature—8:20 P.M., 9 degrees below zero; 10 P.M., 10 degrees below.

Inside temperature—average 45 degrees.

Relative humidity at 8:30, 93; at 10 P. M., 89.

Outtake flues open, 2; intake flues open, none.

Changes of air per hour—1.24 (average of 15 flue tests).

Cubic Feet per hour per animal—670.

Average volume through each outtake flue per minute 145 cubic feet.

Greatest variation from average—14 cubic feet.

Morning of Wednesday, January 21, 1920, (8:55 to 10:00)

Wind—light, west.

Outside temperature—At 8 A.M., 22 degrees below zero; at 12 o'clock noon, 7 degrees below zero.

Minimum temperature—24 degrees below zero.

Inside temperature—average 44 degrees Fahrenheit.

Relative humidity—93 at noon.

Outtake flues open—2 (No intake flues).

Changes of air per hour, 1.03 (average of 19 flue tests).

Cubic feet per hour per animal (25 in stable)—580.

Greatest minimum variation from average—14.2 cubic feet. Tests on flue No. 1 (10:09 to 10:20).

Average volume per minute of six tests—101 cubic feet.

At times during the morning the foul air was backdrafting down from the stable and out the cold air intake slots of the outtake flues. A slight frost about these slots showed that this had occurred to a certain extent during the night. During all the tests, however, there was no evidence of the outtake flues backdrafting into the stable.

Building Farm Drainage Ditches with Water

By **W. W. Johnston**

Assistant in Soils, Oregon Agricultural Experiment Station

THE use of water in moving dirt is not a new factor in Malheur County, Oregon, for as early as in 1881 a larger part of the excavation for the old Nevada irrigation ditch was accomplished by this method. This work was done by C. W. Mallett, of Ontario, Oregon. Other irrigation ditches and one or two large drainage ditches are reported to have been sluiced out in Snake River Valley. This article, therefore, simply reports a new adaptation of an old method and deals with the construction of small but deep drainage ditches calculated to serve individual farmers or small groups of farmers.

The first ditch on which the sluicing method was tried was constructed by the Oregon agricultural experiment station, in cooperation with Glenn E. Burrelle, the owner of the land on which the drain was built. This ditch was built for the purpose of draining a plot of land on which the station is conducting experiments calculated to determine the best method of reclaiming naturally alkaline land in this section. This field, besides being located within a quarter of a mile of the Malheur River, adjoins a deep slough; and since the surface of the soil is fully 15 feet above the water level of the river a need for drainage would usually not be expected. In this instance, however, the natural drainage has been hindered by a number of hardpan dikes, running parallel to the river, the first one extending to a depth of about 12 feet where it connects with a layer of almost impervious, putty-like clay, a condition which had prevented the proper drainage of the land. The remainder of the field was found to be underlaid with streaks of hardpan running parallel to the first occurring some 2½ to 5 feet from the surface and varying in thickness from 2 inches to 2 feet. The surface soil was not water-logged and the water table was from 4½ to 6 feet from the surface. The drainage ditch was so located that it would cut through these hardpan layers and consequently part of the excavation included the removal of hardpan. The surface soil was found to be a clay loam and the subsoil was only slightly lighter in texture. Some streaks of sand and gravel were also encountered.

Since it was considered desirable to have some earth for refilling in case tile should be put in later and in order to have a good base for sluicing operations a ditch 2½ feet deep, 9 feet wide at the top, and 8 feet wide at the bottom was built with a fresno, a groove 6 inches deep and the width of a slip scraper being made in the bottom in order to confine the water to a narrow channel.

It was first planned to sluice by keeping the water falling with a straight drop of 5 feet or more and to loosen the earth by working on the perpendicular surface beneath the falls with a long bar, the idea being that the dirt would be broken off in large pieces which would be further broken up and put into suspension by the force of the falling water. With this end in view 70 feet of the outlet, where the ditch crosses a shallow slough, was taken down to grade with scrapers leaving the end of the ditch with a perpendicular drop of about 10 feet. This system was found to be fairly successful, as were a number of others that were tried, but the hand method which was finally adopted in building this ditch was to loosen the earth with a shovel while the water was running, instead of using the straight drop, the ditch was sluiced back in a series of layers each about 16 inches deep

and about 40 feet long, so that the ditch was taken to grade as the work progressed.

When hardpan was encountered it was found necessary to break it up with a pick. Small quantities were found to sluice out without difficulty, but when a considerable amount was encountered the larger particles settled to the bottom and it was necessary to loosen this material again and throw some of the larger pieces out by hand. Some of the worst hardpan layers were removed with a pick and shovel without the aid of the water. Whenever it was possible to break up the hardpan into small pieces it sluiced out without difficulty.

The 676 feet of the ditch which is now completed and which averages 11 feet in depth required 353½ hours of man labor and 209½ hours of horse labor, or the equivalent of one man working 353½ hours and one horse working 209½ hours. This included also the labor required for the fresno work for 200 feet in addition to the amount which is now completed and all the work on the outlet, etc., the cost of which will ultimately be distributed over several hundred more feet of drain. Figuring man labor at 35 cents an hour and horse labor at 12½ cents an hour the cost of digging the drain would be $149.90. Charging all the labor to date to the 676 feet now completed the cost per foot of drain would be a fraction over 22 cents and the cost per yard of earth removed would be approximately 14 cents. These figures of course include the fresno work and pick and shovel work as well as the actual sluicing. The cost of sluicing where no hardpan was encountered and the earth sluiced easily was approximately 6 cents a yard.

A plow was used with some success in loosening the earth for sluicing, but for the short ditch that was being made it was found impracticable to go to the expense of rigging up to give this method a thorough trial. It showed considerable promise, however, and would probably work best on a large ditch and for the first few feet of excavation.

A cultivator was used with marked success. This tool was used for taking out the last dirt after the ditch was practically completed; in the half day that it was used the loose earth was sluiced from the entire length of the drain and a cut of about 6 inches was made in addition. The handles were set close together so that it could be handled in the bottom of the ditch without difficulty, and it was fastened by means of a 20-foot cable to the center of two-by-fours 18 feet long which extended across the ditch. A horse was hitched to each end of the improvised doubletree to haul the cultivator. It was only possible to use this tool one way for it could not be held in place against the force of water when it was attempted to pull it up the stream.

This work with the plow and cultivator showed that there was a need for some kind of tool that would work in the bottom of the ditch without requiring a man to guide it. Percy Purvis, who lives near Vale, has developed a tool patterned after a threshing machine cylinder, but with specially prepared teeth, designed to meet this requirement. This machine is shown in the accompanying illustrations. The machine is made of five iron hoops placed parallel to each other and about 10 inches apart, being held in place by five pieces of strap iron running perpendicular to the hoops and at regular intervals. Each hoop contains ten sharpened cylinder teeth, the first two rows of which have cutting edges and are so placed that the teeth on the preceding hoop will not come directly behind those of the first but will bisect the space between them. Those on the third hoop are placed so that they will bisect the interval between the first and second and the teeth on the other hoops are placed correspondingly so that no two teeth will run in the same groove. The teeth on the last three hoops have flat or scraping surfaces.

The device is 5 feet in length, 19 inches in diameter, and weighs about 75 pounds. It is drawn through the trench by horse power. A long pole is placed across the ditch, and a long chain from the center of it to the sluicing machine is connected from the center to the sluicing machine, where it fastens on a swivel, making it possible for the machine to rotate as it goes through the trench. A horse is hitched to each end of the pole and the tool is dragged up and down the trench while a head of about 5 second-feet of water is running through the ditch.

The only crew required to operate the machine is a boy to lead each horse; for best results two men should be employed at the same time to keep the banks dressed down and to insure that the sides have the proper slope, which will result in the building of a permanent ditch and will also prevent caving in while the work is still in progress.

While Mr. Purvis has not kept an accurate record of the time spent in his ditching operations so as to make a definite statement of the cost of sluicing possible, it is certain that the cost has not exceeded 5 or 6 cents a cubic yard. The actual saving in cost of excavation per cubic yard does not represent the entire benefit derived from the system of building drainage ditches; for where conditions are such that the sluicing method will work, it is possible for small groups of farmers to put in the deep drains required (8 to 12 feet), for the proper drainage of irrigated soil without purchasing expensive trenching machines, the cost of which is usually prohibitive excepting for large districts. Excavation to a depth greater than 5 feet cannot be economically accomplished with fresnos, due to the fact that an excessively large ditch must be made in order to make room for the horses to work; and since hand digging of deep drains cannot well be done under present labor conditions the two methods first mentioned are about the only ones that can be used.

At a field day held under the auspices of the Malheur County Farm Bureau in early September, 1921, an opportunity was given to the local people to observe the results of the experiment station's work and also to see Mr. Purvis' machine in operation. At this meeting Mr. Purvis made his invention public property.

Sluicing tool developed by Percy Purvis of Oregon

Agricultural Engineering Development

A Review of the Activities and Recent Progress in the Field of Agricultural Engineering Investigation, Experimentation and Research

Edited by **R. W. Trullinger**
Mem. A.S.A.E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

THE EFFECT OF CHALK ON THE CULTIVATION OF HEAVY LAND, E. J. Russell and B. A. Keen [Journal of the Ministry of Agriculture, London, 28, (1921), No. 5, pp. 419-422.] Experiments conducted at the Rothamsted experimental station are reported in which heavy soils were treated with lime and the resistance to tractor plowing on the limed and unlimed soils determined by dynamometer measurements. The field was plowed in October immediately after the removal of the oats crop, and was cross plowed in the following March. The measurements were taken during the cross plowing. The cross plowing was done by an Austin tractor using a Ransome three-furrow plow, and a Cockshutt three-furrow plow. The results are shown in the accompanying table, together with the average of all results.

MEASUREMENTS FOR CROSS PLOWING LAND ALREADY PLOWED IN AUTUMN

COCKSHUTT PLOW, AUSTIN TRACTOR

AVERAGE	Unchalked		Chalked, 20 Loads Fine Chalk		Chalked, 50 Loads "Dug" Chalk	
	Center Plot	S.E. Plot	Center Plot	S.E. Plot	Center Plot	S.E. Plot
Miles per hour........	2.14	2.21	2.50	2.27	2.27	1.88
Draft per plow, lbs...	516	509	465	446	483	417
Draft per sq. in. in furrow section, lbs...	7.37	7.12	6.63	6.37	6.90	5.95
Drawbar pull, lbs.....	1,548	1,527	1,395	1,337	1,450	1,250

RANSOME PLOW, AUSTIN TRACTOR

	Unchalked	Chalked, 20 Loads Fine Chalk	Chalked, 50 Loads "Dug" Chalk
Miles per hour........	1.98	2.15	22.7
Draft per plow, lbs...	537	467	483
Draft per sq. in. in furrow section, lbs...	7.67	6.67	6.90
Drawbar pull, lbs.....	1,610	1,400	1,450

Depth of plowing, 7 inches

Average of All Results	Unchalked	Chalked
Miles per hour	2.11	2.22
Draft per plow, lbs.	521	461
Draft per sq. in. in furrow section, lbs.	7.39	6.57
Drawbar pull, lbs.	1,562	1,380

Further experiments using a Ransome plow and a Titan tractor showed that the difference between limed and unlimed soils becomes even more striking when a heavier tractor is used with the heavy plow. A part of this difference is apparently due to the heavier weight of the plow, but the greater portion is attributed to the compacting of the soil in front of the plow by the Titan tractor which weighs 6,000 pounds as against 3,000 pounds for the Austin tractor.

These results are taken to indicate that the liming or chalking of heavy land should be regarded as one of the essential factors to be considered in the use of the tractor.

THE USE OF EXPLOSIVES IN AGRICULTURE. C. Ulpiani, L. Cesaroni, and A. Gentile; [Pubblicazioni della Stazioni Agraria Sperimental in Bari per lo Studio Dell' Aridocultura, Bari, Italy, 1,(1919), No. 1 pp. 32.] This report deals with the use of surplus war explosives in Italy for the blasting and clearing of rock, soils and for tree planting.

Experiments conducted at the Bari experiment station with ballistite, solenite, cordite, picric acid, and nitrocellulose are described. The conclusion is drawn that these explosives may profitably be used for the planting of orchards and vineyards in rocky and hilly regions, but not on meadows and pastures.

THE SPRAYING OF FIELDS WITH MUNICIPAL SEWAGE, M. Strell, [*Gesundheits-Ingenieur,* Munchen, Germany, 44 (1921), No. 22, pp. 257-262, Figs. 13.] Experiments with three different types of spray irrigation apparatus to determine their usefulness in the distribution of clarified and partially clarified sewage effluent from municipal sewage disposal systems are reported.

One system is designed to aid in furrow irrigation, one simulates rain, while the other makes a strong spray. Apparently the difference is mainly one of design and arrangement of nozzle and of pressure imposed. The fields to be irrigated are laid off about 600 meters, (135 feet) wide with a main distribution pipe down the center with openings for lateral connections. Lateral pipes on hexagonal shaped wheels are connected to the main pipe at the openings and may thus be moved up and down the field to the positions desired.

It is concluded that municipal sewage with a low content of suspended matter (about 1.5 cubic centimeters per liter of sewage) may be profitably disposed of on fields with such apparatus, without any special preliminary treatment. The suspended matter should be in finely divided condition, however. Where coarse suspended matter is present preliminary screening or sedimentation is necessary. For both spray and spray-furrow irrigation a pressure of at least 3 atmospheres (about 44.1 pounds per square inch) is considered desirable.

THE HEAT CONDUCTIVITY OF BUILDING AND INSULATING MATERIALS AND HEAT PERMEABILITY FACTORS OF NEW STRUCTURES, O. Knoblauch, E. Raisch, and H. Reiher [*Gesundheits-Ingenieur, Munchen, Germany,* 43, (1920), No. 52, pp. 607-623, Figs. 4.] In part 1 of this paper laboratory apparatus is described for determining the heat transmission coefficient of insulating and structural materials in calories per hour per degree centigrade difference in temperature, through a cube of material having edges one meter long and with four of the six faces completely protected against heat transmission. The results of tests of a number of materials are also reported.

In Part 2 studies are reported with experimental buildings to determine the permeability of building materials for heat and their heat transmission coefficients. It was generally established that the heat transmission coefficient for most building and insulating materials increases with temperature, specific gravity, and moisture content. The results from the testing apparatus and from experimental buildings correspond closely. It is recommended that in testing damp materials the smallest possible temperature differences be used to avoid variation in moisture content during test.

Some of the more important results obtained are given in the following tables:

STRUCTURAL MATERIALS

MATERIAL	Volume Weight, Kilograms Per Cubic Meter	Moisture Content, Per Cent	Heat Transmission Coefficient, Calories Per Meter Per Hour Per Degree Centigrade
Brick	1620	0.00	0.41
Brick	1620	0.08	0.43
Brick	1620	0.90	0.60
Brick	1620	1.81	0.82
Pumice concrete	800	10.3	0.24
Slag concrete	800	10.3	0.24
Plain concrete	1600		0.72
Plain concrete	2300	10.2	1.04
Lime sandstone	1650	15.3	0.80
Straw adobe	1505	0.00	0.35
Mud wall	1900	5.7	0.52
Adobe unburned	1775	7.4	0.60
Adobe unburned	1775	10.0	0.80
Hollow tile			0.17
Hollow tile			0.35
Stone brick	812		0.16
Sandstone	2259		1.22
River stone	630		0.11
Blast furnace slag	785		0.14
Mixture 12 parts sand 4 parts lime	1820	1.37	0.58
Mixture 12 parts sand, 4 parts lime, 1 part cement	1870	1.96	0.46
Gypsum	1250		0.36
Gypsum and fiber	670		0.12 to 0.24
Asphalt	2120		0.52
Pine wood	546		0.12
Teak wood	642		0.14
Fir	825		0.17
Hardwood	588		0.094
Asbestos	1790		0.13
Cement wood, dry	715	0.4	0.11
Cement wood, wet	824	12.4	0.14
Quick sand	1520	0.00	0.27
Quick sand	1640	11.3	0.96
Silica sand	1850		0.29
Loamy sand	2020	28.3	2.0

INSULATING MATERIALS

MATERIAL	Volume Weight Kilograms Per Cubic Meter	Heat Transmission Coefficient. Calories Per Meter Per Hour Per Degree Centigrade
Ground cork	85	0.038
Ground cork, 3/5	46	0.031
Ground cork, ½	46	0.027
Cork linoleum	535	0.069
Linoleum	1183	0.15
Tree bark	342	0.057
Peat	192	0.048
Peat	371	0.062
Peat	728	0.095
Peat	830	0.142
Pressed straw	139	0.039
Hair wool	90	0.032
Pressed horse hair	172	0.042
Blast furnace slag	360	0.095
Pumice sand	301	0.075
Coal slag	697	0.12
Sawdust	215	0.060
Reeds	75	0.04
Peat litter, dry	190	0.041
Peat litter, damp	190	0.060

TESTS OF LIME NITROGEN FERTILIZER SPREADERS, G. Fischer, [*Mitteilungen der Deutschen Landwirtschafts-Gesellschaft*, Berlin, 36, (1921), No. 23, pp. 351-358.] Tests of fifteen different lime nitrogen fertilizer spreaders are reported. While the tests were competitive they were apparently not essentially comparative since they constituted a part of a study to determine suitable methods and apparatus for the distribution of oiled and unoiled lime nitrogen in and over the soil with a minimum of nuisance occasioned by dustiness.

A preliminary analysis of what such a distributor should accomplish indicated that it should be capable of uniformly drilling and broadspreading lime nitrogen, according to adjustment, without the development of a dusty condition. The lime nitrogen should be introduced into the distributor box without dust and should be discharged automatically. The machine should also be capable of distributing other fertilizer salts.

As a result of these studies the following suggestions and recommendations are made for the guidance of implement manufacturers: The best fertilizer distributor apparatus is the type in which a chain moves horizontally over rollers in a box and forces fertilizer through slits or holes into the discharging pipes. There is a tendency, however, for small quantities of the fertilizer not to be divided finely enough in this apparatus. Flowing fertilizer salts should not be stirred and should be moved as little as possible, and then only in the discharging apparatus.

Machines with movable slits and holes in a box which contains a shaft fitted with expelling members are useful for lime nitrogen and other dry, powdery fertilizers containing no solid particles. The expelling members on the shaft must operate steadily, and the width of the slits or holes must be accurate and uniform to prevent excessive wear.

Since lime nitrogen has a tendency to adhere to flat surfaces, all surfaces along which it moves or with which it comes in contact should be vertical as nearly as possible. Pulverizing projections in the distributor box are therefore to be avoided. If fertilizer is to be distributed in rows over a broad surface through individual discharge conduits the funnel walls leading to the discharges should have plenty of slope.

The surest dust protection is obtained through the use of pipe conduits. These can be so spaced as to produce both broadspread and row fertilization. Dustiness can be prevented or reduced in broadspread fertilization by slit or chain machines only by boxes which are closed at the sides as well as front and rear. The distribution openings must be so tightly constructed that no fertilizer can escape either during filling or emptying. When this is impossible, catch grooves should be provided to prevent an excess of lime nitrogen from falling on the soil. An open or half covered box is not sufficient to prevent dustiness when filling the box. Funnels placed in holes on the box top are better but are not perfect. Better results are to be expected from a closed box with valve openings as connections between the sack and the box. The construction of a dusttight lifting and tipping arrangement for sacks is also desirable.

For large scale work the distributor should cover a width of four meters (13.12 feet) and should require only one man for operation and not more than two horses for draft. A second man is permissible for steering the row fertilization apparatus. Provision should be made for opening or tipping up the box for complete cleaning, and the discharging apparatus should be easily cleaned. The apparatus for adjusting the rate and amount of fertilization should be sufficiently sensitive to permit small variations to be made easily and accurately.

A. S. A. E. and Related Activities

A.S.A.E. Officers for 1922

THE ballot for officers of the American Society of Agricultural Engineers for 1922 has resulted as follows:

President, A. J. R. Curtis, Portland Cement Association, Chicago, Illinois.

First vice-president, G. W. McCuen, department of agricultural engineering, Ohio State University, Columbus, Ohio.

Second vice-president, David Weeks, Dakota Engineering Company, Mitchell, South Dakota.

Treasurer, F. P. Hanson, Portland Cement Association, Chicago, Illinois.

Councilman for three years, G. W. Iverson, Advance-Rumely Company, La Porte, Indiana.

Nominating committee: O. W. Sjogren, chairman; W. G. Kaiser, and P. S. Rose.

The election of members on the advisory committee of the College Section elected by the members of that Section resulted as follows:

For two years, F. W. Ives, Ohio State University, and J. B. Davidson, Iowa State College.

For one year, H. H. Musselman, Michigan Agricultural College, and W. J. Gilmore, Oregon Agricultural College.

Employment Service

THE publication monthly in AGRICULTURAL ENGINEERING of an employment service bulletin begins with this issue. This service is primarily for the benefit of members of the American Society of Agricultural Engineers who are seeking employment or who have positions to fill. The Society is not in position to conduct in detail negotiations for employment between prospective employees and employers, but it will act as a clearing house for putting those members whose services are available in touch with those who have positions to fill, and vice versa.

Non-members, as well as members, are privileged to use the "Positions Available" section, and in this connection members of the Society are urged to communicate immediately to the Secretary any positions they may know to be open. The effectiveness and value of this service will be greatly augmented by the cooperation of members.

Ohio State Tractor Schools

THE department of agricultural engineering at the Ohio State University, in cooperation with the department of agricultural education at that institution, is making plans for conducting about forty tractor schools throughout the state during the coming winter. The first school will be started about December 5 and extend to December 23. This school will be held near Columbus so that it can have the close supervision of the agricultural engineering staff at the University. It is planned to accommodate from twenty to twenty-five men at each of these different schools, and the present indications are that practically every one of the schools will be filled.

The department of agricultural engineering is assured of the very best cooperation from farmers who have tractors to overhaul and garage men throughout the state interested in the work. It is planned to follow the Mann method of instruction in these schools, which consists of (1) telling the student about it, (2) actually doing the work so the student can see how it is done, and (3) letting the student do it for himself.

The agricultural education department at the University is entering into the project with a great deal of enthusiasm and everything points to a very successful series of schools.

A.S.A.E. Member with American Farm Equipment in Palestine

THE members of the American Society of Agricultural Engineers will be glad to hear of the safe arrival of Mr. M. L. Kasselman of the Ohio State University and a member of this Society at Jaffa, Palestine. Mr. Kasselman was selected by the examining board of the Society of Zionist Engineers and Agriculturists as the man to accompany the first shipment of agricultural machinery which was sent from America as a gift to the Palestinian workers.

Already several thousand Jews from Russia, Poland and other Central European countries have arrived in Palestine, and many thousands more will settle there within the next few months. As agriculture is the principal industry of the land, the settlers will require large numbers of agricultural tools and machinery. It is in order to supply this need that last spring a campaign was started in the principal cities and towns of the United States and Canada, and about $100,000 worth of tools and machinery was sent during August to Palestine. Not only have the American workers sent tools, but they sent several experienced mechanics for the operation and teaching the working of these tools to the Palestinian workers, and among these mechanics was Mr. Kasselman. It is hoped that as a result of this first shipment many more shipments will be made in the near future.

University of Michigan Offers New Short Courses

THE University of Michigan will offer during the winter period of 1921-1922 courses covering periods of two weeks each for men engaged in the practice of highway transport. A man may take a single course, or if he prefers he may take a group of courses.

The first course will open December 5 and continue until December 16, covering the American and English highway transport methods. The second, beginning December 19 and continuing until December 31, will be on highway transport legislation and traffic regulations. The course beginning January 2, continuing until January 13, will cover interrelationship of highway, railway, and waterway transport. The fourth, which will open January 16 and continue to January 27, will cover highway transport costs and record systems. The fifth, covering mechanism, operation, and maintenance of motor trucks, tractors, and trailers, will open January 30 and close February 10. This course will also include highway transport management. Highway transport economics and surveys will be taken up in the sixth

course, which course opens on February 20 and closes March 3. The seventh and last, highway transport seminar will open March 6 and continue to March 17.

It is stated that the University of Michigan is the only institution which offers courses of this kind for men engaged in the practice of highway transport and which may be taken during leaves of absence of from two weeks to four months.

Complete information regarding this series of courses may be obtained by writing Prof. Arthur H. Blanchard, University of Michigan, Ann Arbor, Michigan.

Patent Office Legislation

AT ITS meeting held in Washington, September 30, 1921, the executive board of the American Engineering Council of the Federated American Engineering Societies approved the report of the committee on patents, which contained the following resolution:

"WHEREAS, American Engineering Council, of the Federated American Engineering Societies, representing 43,000 engineers in member and affiliated societies, is strongly convinced of the importance of the Patent Office to the maintenance of the manufacturing and agricultural welfare and supremacy of the United States and is deeply concerned over the present precarious and inefficient condition of the Patent Office, the said American Engineering Council represents to Congress that, while the Patent Office was in a most serious condition in 1919, when the need of its relief was first brought to the attention of Congress, the work of the Patent Office has increased 67.6 per cent, since that time, while the Patent Office force has only been increased 5.4 per cent, the salaries of examiners remaining at but 10 per cent more than they were in 1848 and the resignations of the Patent Office examiners have continued in increasing volume until but one-half of the examining force now consists of properly trained examiners; and

"WHEREAS, the Lampert Patent Office Bill, H. R. 7077, provides the least increases in force and salaries which can possibly stop the retrogression of the Patent Office and enable it to make progress toward recovering an efficient condition, and by increases in the fees for patents, provides the funds necessary to enable the Patent Office to continue to be self-supporting;

"NOW, THEREFORE, AMERICAN ENGINEERING COUNCIL most urgently recommends to Congress the passage of the said Lampert Patent Office Bill, H.R. 7077."

The American Engineering Council earnestly urges every engineer to write or telegraph his senators and representative in Congress, urging the immediate enactment of the Lampert Patent Office Bill, H. R. 7077.

It is important that members of the American Society of Agricultural Engineers give this matter their prompt attention and comply with the request of the American Engineering Council. The Patent Office has for years suffered from lack of funds for support and as a result American industry and commerce have been seriously retarded. The earnest support of individual engineers will materially aid in bringing about the passage of the Lampert Patent Office Bill, which will enable the Patent Office to render the efficient service demanded at this time.

Personal Items of Members

MAX E. COOK is farmstead engineer of the Dehli State Settlement, a project of the Land Settlement Board of the State of California, of which Dr. Elwood Mead is chairman. His work consists of making plans and supervising construction of settlers' houses and other buildings on the settlement, which embraces not only planning, designing, quantity surveying, obtaining comparative bids, letting contracts, and supervising construction of all classes of farm, townsite, and administrative buildings, but also includes making individual farmstead layouts for all settlers, determining location and arrangement of buildings, lanes, corrals, poultry runs, domestic wells, orchards, vegetable gardens, etc.

JAMES KOEBER is now connected with the division of Agricultural engineering of the University of California as specialist in agricultural engineering.

P. ARTHUR TANNER recently became assistant general manager of the Johnson Motor Company, South Bend, Indiana, manufacturers of the Johnson motor wheel, the Quick-Action magneto, and a new outboard motor.

L. R. VAN VALKENBURG, formerly service engineer for Avery Company, recently became associated with the Grain Belt Tractor Company, Fargo, North Dakota, whose plant is being turned into a school of mechanics, known as the Grain Belt School of Mechanics. Mr. Van Valkenburg holds the position of superintendent and instruction will be given in automobile, truck, tractor, and gas engineering, also in machine-shop work.

H. B. WALKER became the head of the department of agricultural engineering at the Kansas State Agricultural College on July 1. Mr. Walker has been engaged in agricultural-engineering work with the extension division of K. S. A. C. since his graduation in civil engineering from the Iowa State College in 1910. Mr. Walker has served in many important advisory and consulting capacities in drainage and irrigation work, and during the war was a captain of engineers in the U. S. Army. In addition to being a member of this Society he is also a member of the following engineering societies: American Society of Civil Engineers, Kansas Engineering Society, the American Association of Engineers, and the Society for the Promotion of Engineering Education.

Wanted—Correct Addresses of These A. S. A. E. Members

NOTE: Mail is being returned from the addresses given below. These members, or others who know of their whereabouts, are requested to send the Secretary their correct addresses at once. Inasmuch as delivery cannot now be made, AGRICULTURAL ENGINEERING will not be mailed until correct addresses are received.

Charles J. Baker, 122 Theodore Street, Detroit, Michigan.

Joaquim Bertino de Moraes Carvalho, Directoria Geral da Industria Pastoril Rua Matta Machando, Rio de Janeiro, Brazil, South America.

J. D. Eggleston, 1638 Iowa Street, Dubuque, Iowa.

A. M. Leoni, 4832 Reisterstown Road, Baltimore, Maryland.

Ward R. McGanen, McGanen Tractor Company, Missouri Valley, Iowa.

John Howard Rees, 211 Commerce Building, Columbus, Ohio.

S. Y. Sweeney, 111 East Campbell Avenue, Roanoke, Virginia.

Necrology

George Hubbard Tefft passed away July 7, 1921, at Philadelphia, after but a short illness.

Mr. Tefft was born in Springfield, Missouri, in 1869, the son of a prominent Missouri physician. After leaving college he entered the banking business, and a few years thereafter became connected with the packing industry at Kansas City. Later he became associated with the Walter S. Dickey Clay Manufacturing Company, eventually becoming sales manager of that organization. While in that capacity he was also secretary-treasurer of the International Clay Products Bureau, a body that was instrumental in the promotion of vitrified clay sewer pipe. When this organization was amalgamated with a similar organization in Chicago, Mr. Tefft was made secretary-manager of the new organization known as the Clay Products Association, which position he held from August 1907 to the time of his death. During the latter part of 1920 the Eastern Sewer Pipe Manufacturers Association appointed Mr. Tefft as secretary-manager, so that for the last six months of his life he spent his time between the two offices, at Pittsburgh, Pennsylvania, and Chicago, Illinois.

Ward Cretcher was killed on October 16, 1921 in a motor car accident at Cantril, Iowa. For a short time prior to his death he had been cashier of the State Bank of Cantril. Mr. Cretcher was a graduate in agricultural engineering of the Iowa State College, Ames, Iowa, completing his course with the class of 1920. Following graduation he was connected with the Oregon Agricultural College in active drainage work, continuing in this work until his resignation early in the fall of 1921 to assume the banking connection mentioned.

New Members of the Society

Members

Harvey Roy Burr, Williamson School, Pennsylvania.
J. H. Mayne, Council Bluffs, Iowa.
J. R. Rhyne, Corning, Arkansas.
H. B. Roe, University Farm, St. Paul, Minnesota.

Associate Members

George Amundson, Ashland, Wisconsin.
S. P. Lyle, Ames, Iowa.

Junior Members

H. L. Boysel, Springfield, Illinois.
G. G. Butterfield, Auburn, Nebraska.
S. S. Graham, 2709 Boone Street, Ames, Iowa.
Felix D. Maramba, 119 N. Lincoln Way, Ames, Iowa.

Affiliate Members

A. M. Hedge, Sun Company, Toledo, Ohio.

Applicants for Membership

The following is a list of applicants for membership received since the publication of the November issue of Agricultural Engineering. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to their election.

Henry Raymond Herdon, 909 Southwestern Life Building, Dallas, Texas.

D. L. Jantz, Larned, Kansas.

Arthur J. Schwantes, division of agricultural engineering, University Farm, St. Paul, Minnesota.

Lee Stewart, Spooner, Wisconsin.

Let's Grow!

"Every man owes a part of his time to the upbuilding of the business or profession to which he belongs."

These words of Theodore Roosevelt may with special emphasis be applied to members of the American Society of Agricultural Engineers.

That is to say, every A.S.A.E. member owes a part of his time to the upbuilding of the agricultural-engineering profession, of which our Society is the coordinating center.

A.S.A.E. members can perform a distinct service at this time to the agricultural-engineering profession in general and our Society in particular by devoting part of their time to arousing interest in the activities of the Society and securing the applications of new members.

The value of your A.S.A.E. membership increases with the increase in the membership roll of the Society, for the reason that the more members in the Society, the more we have supporting its activities and contributing to the sum total of agricultural-engineering science and development.

The American Society of Agricultural Engineers is essentially a cooperative organization; it is an association of engineers on a give-and-take basis. Each individual member has only so much to "give," but his ability and opportunity to "take" is limited only by the number of members contributing a part of their time and knowledge to A.S.A.E. activities. Obviously, therefore, the more members, the more valuable is your membership to you.

Will you help increase the Society's membership? The Secretary has plenty of application blanks and will help solicit prospective members. The least you can do is to hand him the names and addresses of prospective members. And remember that the new headquarters of the Society is located at St. Joseph, Michigan.

Now, let's grow!

Employment Service

This service, to be conducted by the American Society of Agricultural Engineers, will appear regularly hereafter in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER wants position as experimental agricultural engineer or with some agricultural publication. Graduate, 1918, agricultural college of the University of Illinois. Was editor of the Illinois agricultural students publication in his senior year. For two years employed by an explosives manufacturer as agricultural sales and service man for the State of Wisconsin. At present associated with the land clearing department of the University of Wisconsin. Age 25, married, American. MA-101

CONSULTING ENGINEER AND CHEMIST who has specialized in the design, erection, and operation of edible oil refineries, oil hardening plants, and margarine factories desires position in some phase of agricultural engineering work. MA-102

AGRICULTURAL ENGINEER, with M. E. degree and three and a half years experience in charge of the experimental department of one of the large tractor manufacturers doing experimental and development work on tractors; gasoline, kerosene, and alcohol engines; carburetors; magnetos; hot spot manifolds, and lubricating oils, desires employment with someone developing a tractor for general farm work. MA-103

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104